CHAPTER 5. NORTH & CENTRAL INDIAN RIVER LAGOON

Seagrass and Water Quality

Seagrass Resource Assessment

The status assessment of the seagrass resource in the North and Central IRL is based on the same measurement indices used in the Lagoon-wide and other sub-lagoon assessments. These indices are:

- ❖ Acres of seagrass coverage over time (net gain or loss),
- ❖ Maximum depth of the edge of seagrass beds, and
- ❖ Percent of photosynthetically active sunlight reaching the target depth of 1.7 m.

For more information on why and how these measurement indices are used to assess the seagrass status, refer to Chapter 2, p. 2-3. Major findings on the status of seagrass in North and Central IRL are summarized below.

- The northernmost segments of the Indian River Lagoon (segments IR1-5) exhibited good to excellent seagrass conditions over the last decade, showing even modest gains over the 1943 coverage (Figures 5-1a and b). The segment immediately south of Titusville (IR5) is consistently one of the best in terms of acreage and depth coverage, and routinely surpasses the preliminary 25% light requirement (Figures 5-1b, c and d; Table 5-1). The excellent condition of this segment is exceeded only by Hobe Sound in the South IRL (see Chapter 6).

Table 5-1. General classification of North and Central Indian River Lagoon segments – Good, Fair or Poor

Classification is based on the following indices: *% surface light @ 1.7 m* (as an annual median, see Figures 5-1c and 5-2c), *seagrass depth index* (SDI; see Figures 5-1d and 5-2d), *% loss of seagrass since 1943* (= 50% and = 75%).
Any segment receiving 3 or more marks is classified as poor, 2 marks fair, 1 or zero marks good.

North IRL Segments	= 20% surface light @ 1.7 m	SDI = 75%	loss since '43 = 50%	loss since '43 = 75%	Classification
IR1-3					Good
IR4					Good
IR5					Good
IR6-7	X	X	X		Poor
IR8			X	X	Fair
Central IRL Segments					
IR9-11	X	X	X	X	Poor
IR12	X	X	X		Poor
IR13A	X	X			Fair
IR13B	X				Good
IR14	X				Good
IR15	X	X			Fair
IR16-20	X	X	X		Poor
IR21	X		X		Fair

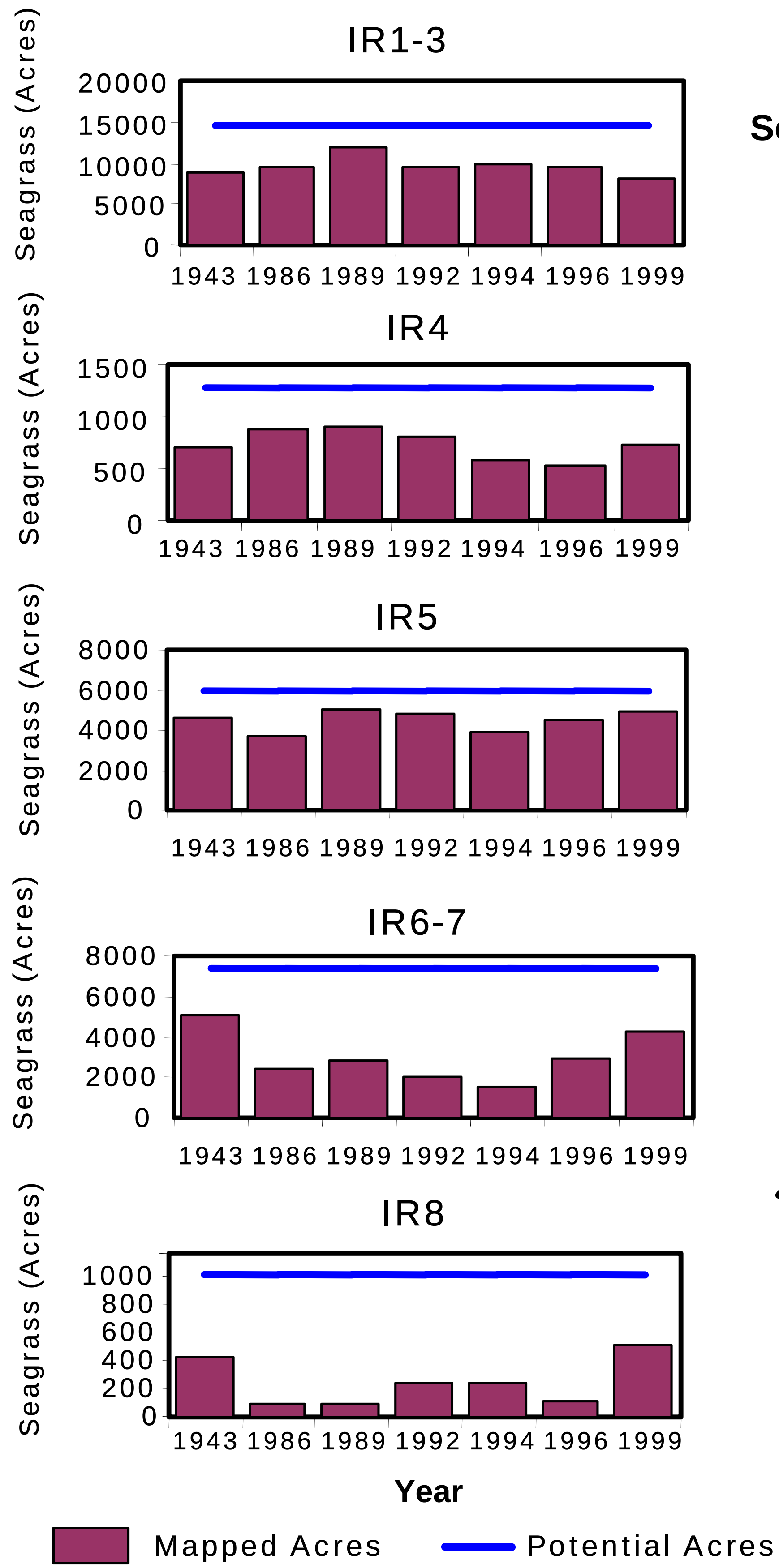

Figure 5-1 b. Acres of seagrass, by segment, in each year mapped. Note differing scales. Potential seagrass acres (the area < 1.7 m deep) are shown as a blue line.

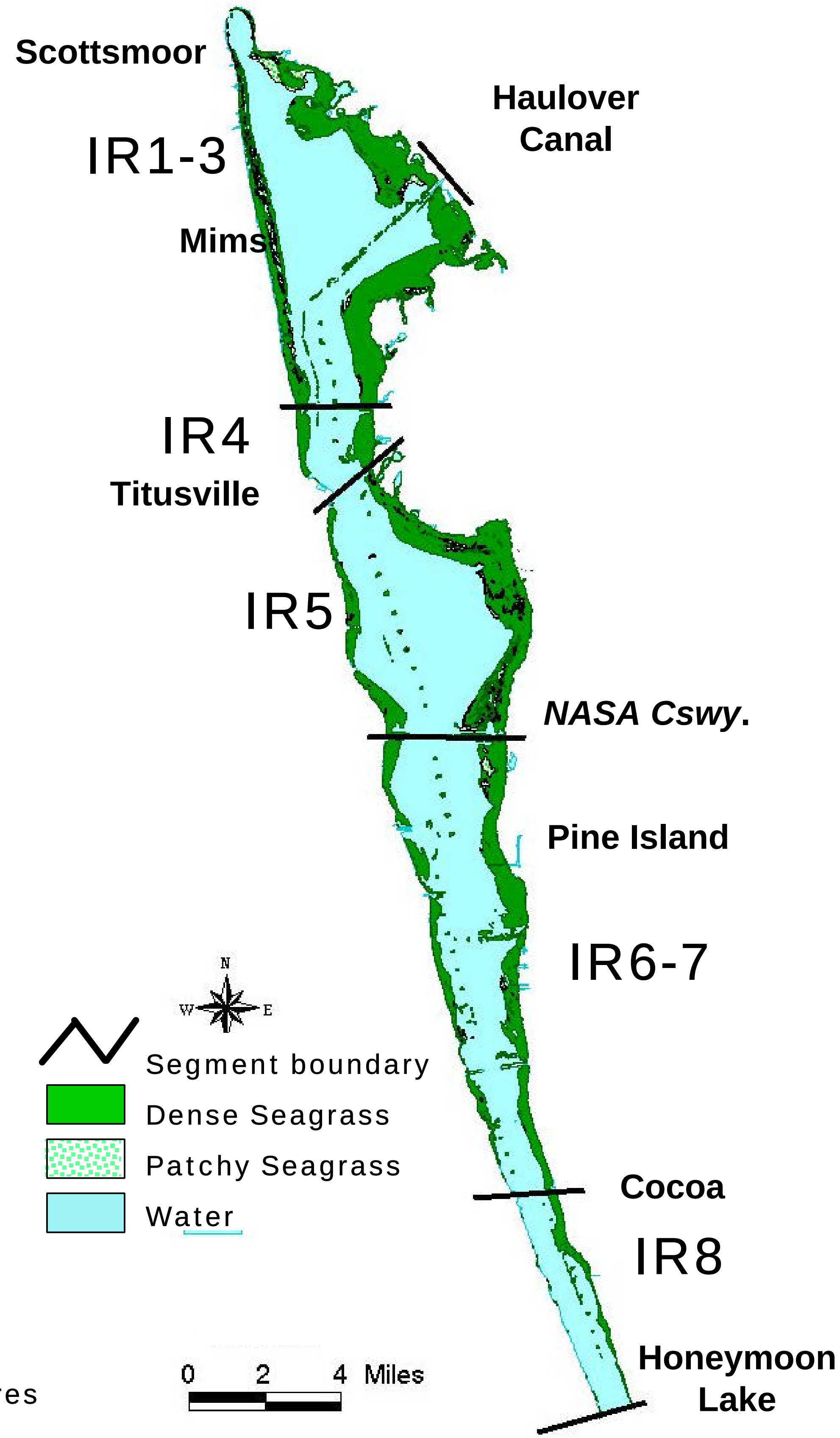

Figure 5-1a. North Indian River Lagoon 1999 seagrass coverage and segment boundaries

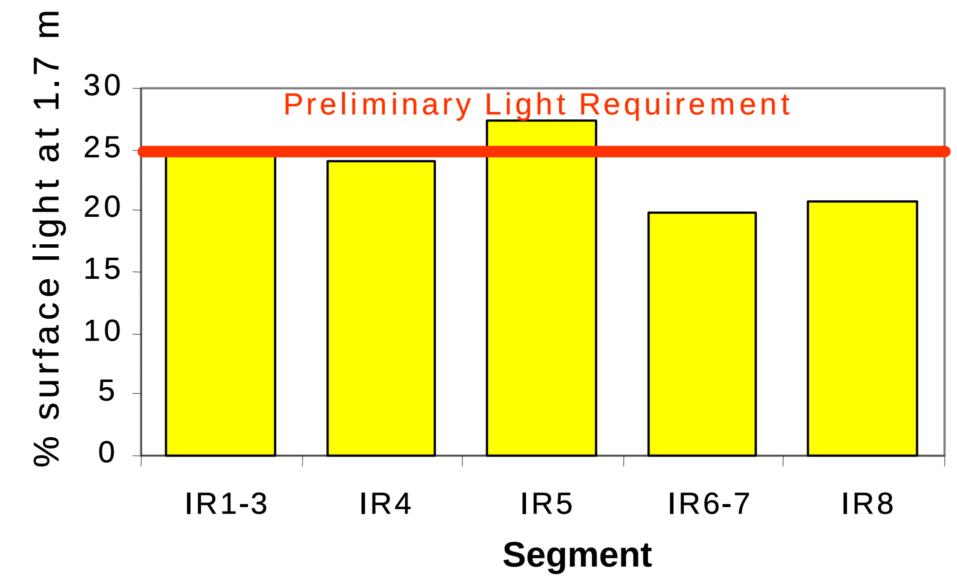

Figure 5-1 c. Median percent surface light at the 1.7-m target depth for each segment, north to south (see map at left for location of segments). Based on monthly measurements from 1990 to 1999. Note how closely the northern three segments meet the target.

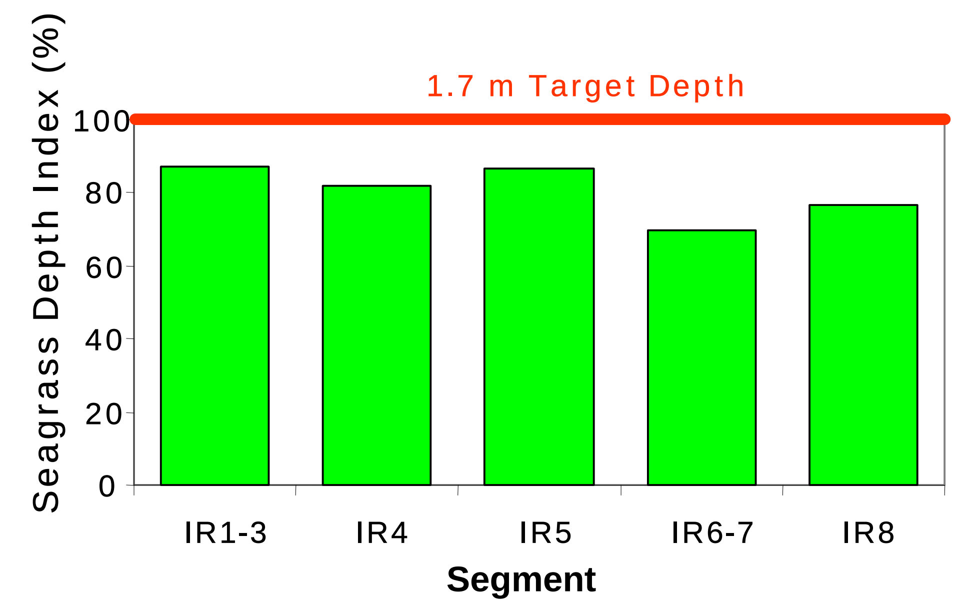

Figure 5-1 d. Average Seagrass Depth Index = depth of edge of bed as a percent of the 1.7-m target depth*. Based on average seagrass deep edges mapped in 1992, 1994, and 1996.

*** The Seagrass Depth Index (SDI) is based on potential coverage to 1.7 m referenced to the NAVD88 vertical datum. The SDI would be slightly less if potential coverage were referenced to mean water level (MWL).**

- Segments near Sebastian Inlet (IR14 and IR13B) in the Central IRL are also considered in good condition; displaying more extensive seagrass coverage in the 1980s and 1990s than in 1943 (Figures 5-2a and b; Table 5-1). A similar trend is observed in the neighboring segment to the south (IR15) (Figure 5-2b).
- The probable factors that allow good seagrass conditions are different in the North than in the Central IRL. The northernmost segments are poorly flushed (about 150 days for complete volume exchange[1]), but their sub-basins are not extensively developed and do not generate the large pollutant inputs characteristic of the Central and South IRL sub-basins. Alternatively, the central segments adjacent to Sebastian Inlet (IR14-15) are located in highly developed sub-basins, but are well flushed primarily due to the inlet tide[2] influence (up to 5 days for complete volume exchange).
- All seven species of seagrass of the IRL system are found in the Central IRL from Sebastian Inlet southward. Only four of the species exist north of Sebastian Inlet[3]. In contrast to its high species diversity, the seagrass status of the Central IRL is the poorest of all the lagoon areas in the IRL system based on the indices above. Most of its segments are classified as poor or fair, except the good segments near Sebastian Inlet (Table 5-1). Most of the Central IRL segments are moderately to poorly flushed (30 to 120 days for complete volume turnover) and are recipients of major inflows of drainage and pollutant loads from large and intensively developed sub-basins (from Eau Gallie south to Vero Beach).
- The worst segments are the Melbourne segments (IR9-12) and Vero Beach segments (IR16-20) (Figure 5-2b and Table 5-1). While the Melbourne area showed modest gains in seagrass coverage in the late 1990s, the coverage in the Vero Beach segment remained quite low (Figure 5-2b). The Vero Beach area is one of the narrowest reaches of the Lagoon, containing a comparatively small basin volume that receives one of the largest annual loads of nitrogen and phosphorus in the IRL system[4].
- Many of the fair and poor segments in the North and Central IRL are noted for their temporal instability; i.e., seagrass coverage fluctuates more widely than in the good segments of the IRL system. One reason for this coverage fluctuation may be the hydrologic variability in the poor segments. The poor segments reside in developed watersheds with extensive drainage systems and thus can be affected by large year-to-year variations in drainage inflows, pollutant loadings, and salinity levels.

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[1] Flushing rate or residence time estimates are based on a preliminary run of the hydrodynamic model component of the IRL PLR Model (Sheng, 1997).

[2] Sebastian Inlet was not routinely maintained as a permanent opening until 1948 (Mehta et al., 1976). Prior to that time, the inlet throat was more narrow, shallow, and often closed, allowing brief and limited exchanges between the ocean and the Lagoon. Therefore, in 1943, the Lagoon at Sebastian was probably more poorly flushed than it is today. This could explain why seagrass coverage was less in 1943 than in recent times.

[3] The seven species are *Thalassia testudinum* (turtle grass), *Halophila johnsonii* (Johnson's seagrass), *Halophila decipiens* (paddle grass), *Halophila engelmannii* (star grass), *Syringodium filiforme* (manatee grass), *Halodule wrightii* (shoal grass), and *Ruppia maritima* (widgeon grass). Only the latter four species are found north of Sebastian Inlet.

[4] The three major canals in Vero Beach and Indian River Farms WCD collectively discharge ~450,000 lb/yr N and ~77,000 lb/yr P to segments IR16-20. Those loadings are equaled or exceeded by only two other riverine inputs -- Sebastian and St. Lucie rivers [Sebastian R.: avg. values of ~631,000 lb/yr N, ~73,000 lb/yr P; St. Lucie R.: median values of ~2 million lb/yr N, and 310,000 lb/yr P (derived from G. Hu, SFWMD, 4/22/02 e-mail)].

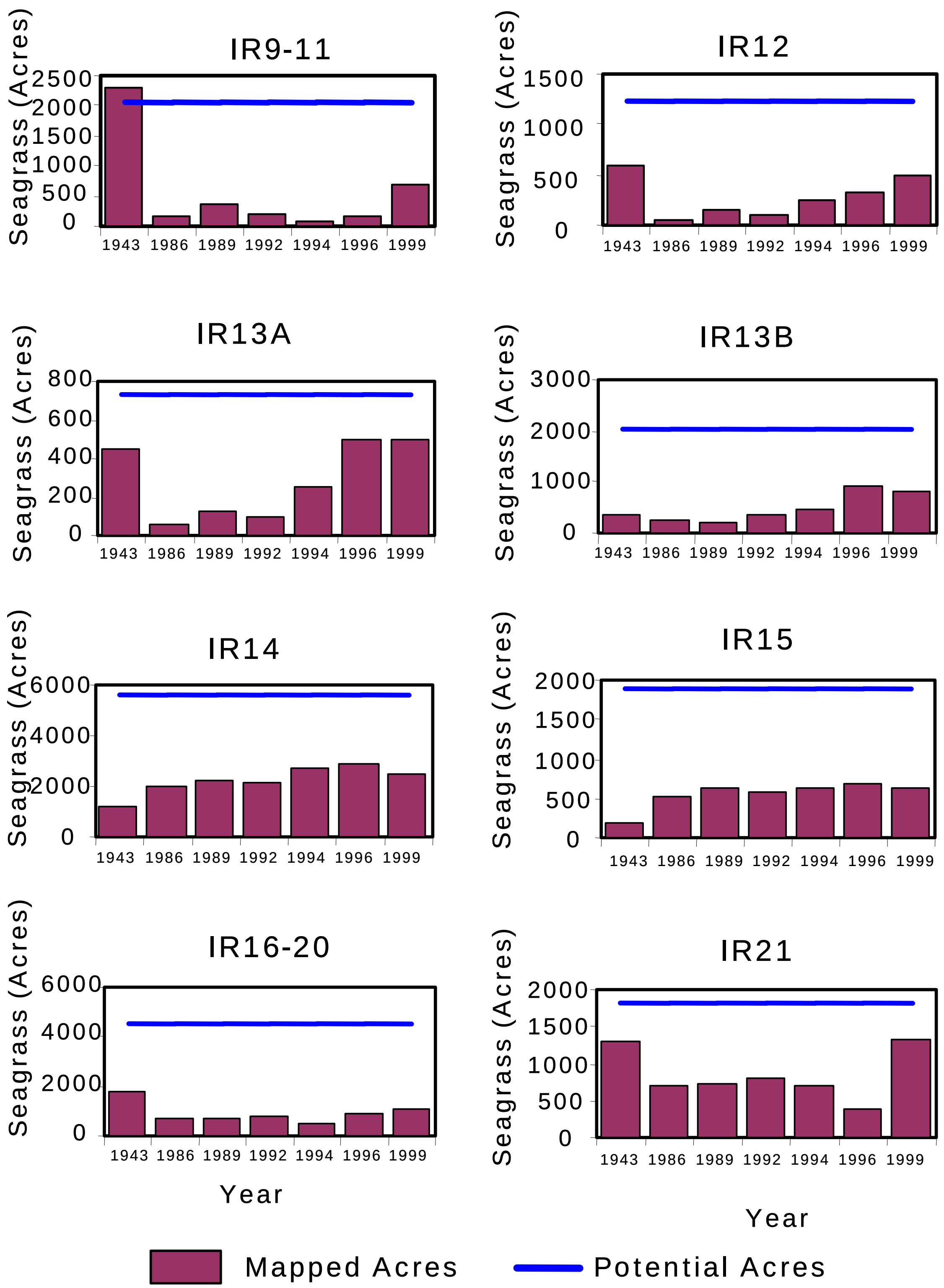

Figure 5-2 b. Acres of seagrass, by segment, in each year mapped. Note differing scales. Potential seagrass acres (the area < 1.7 m deep) are shown as a blue line. Note large historical loss in segments IR9-11, 12, and 13A and recent recovery to near historical levels. Segments IR13B through IR16-20 were never near potential acres. Segments 13B through 15 have more seagrass now than in 1943 – Sebastian Inlet in was not permanently opened until 1948.

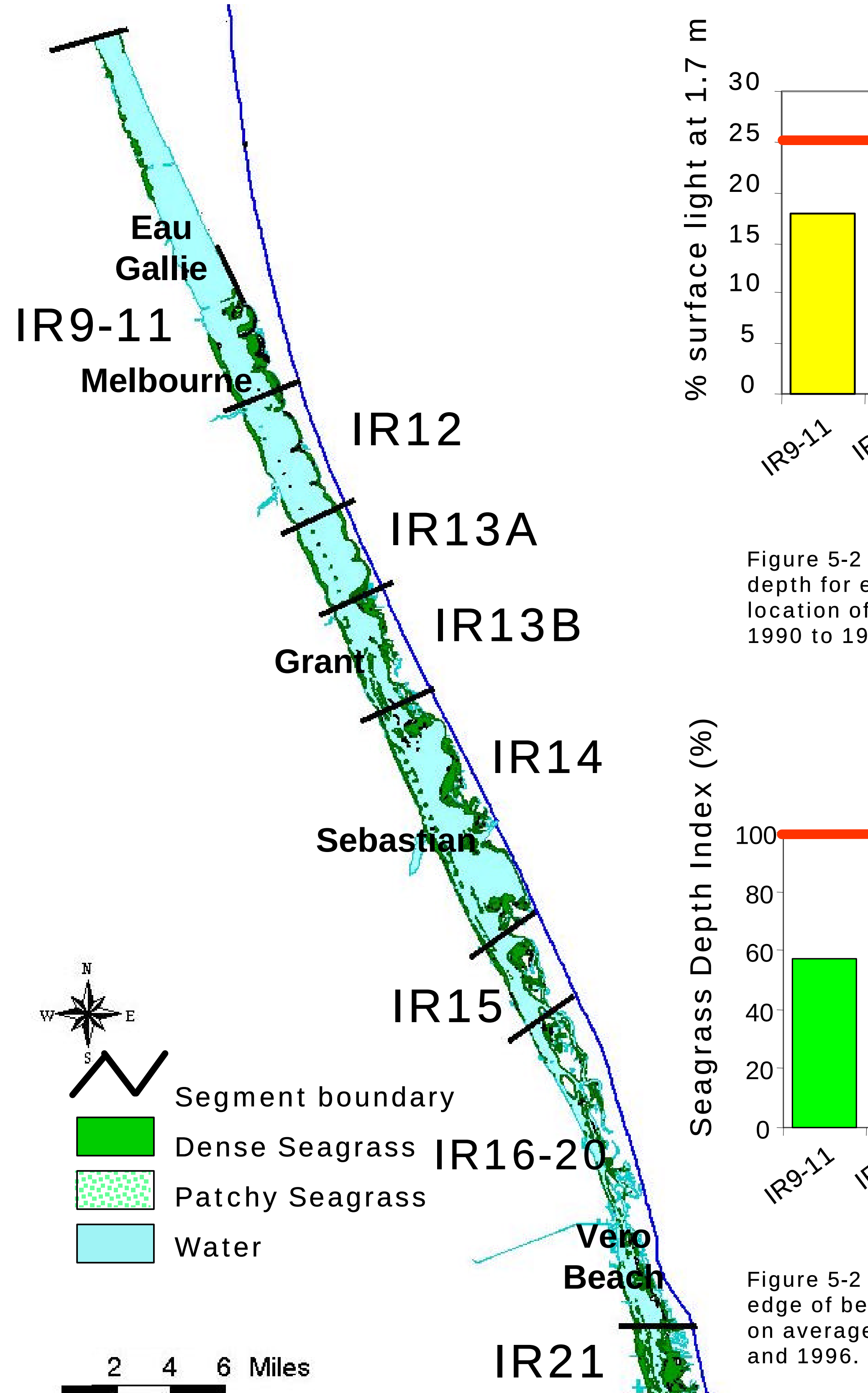

Figure 5-2a. Central Indian River Lagoon 1999 seagrass coverage and segment boundaries

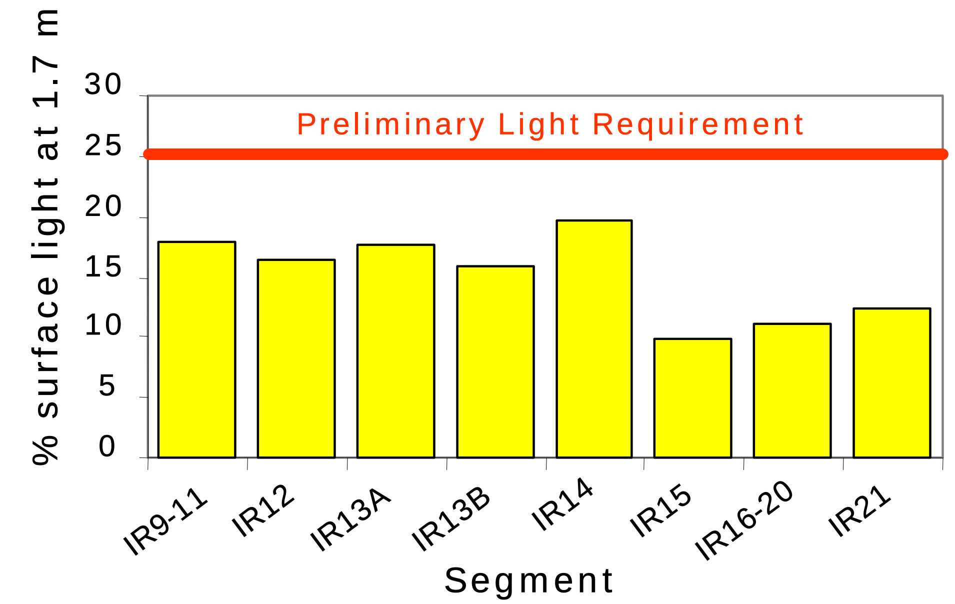

Figure 5-2 c. Median percent surface light at the 1.7-m target depth for each segment, north to south (see map at left for location of segments). Based on monthly measurements from 1990 to 1999.

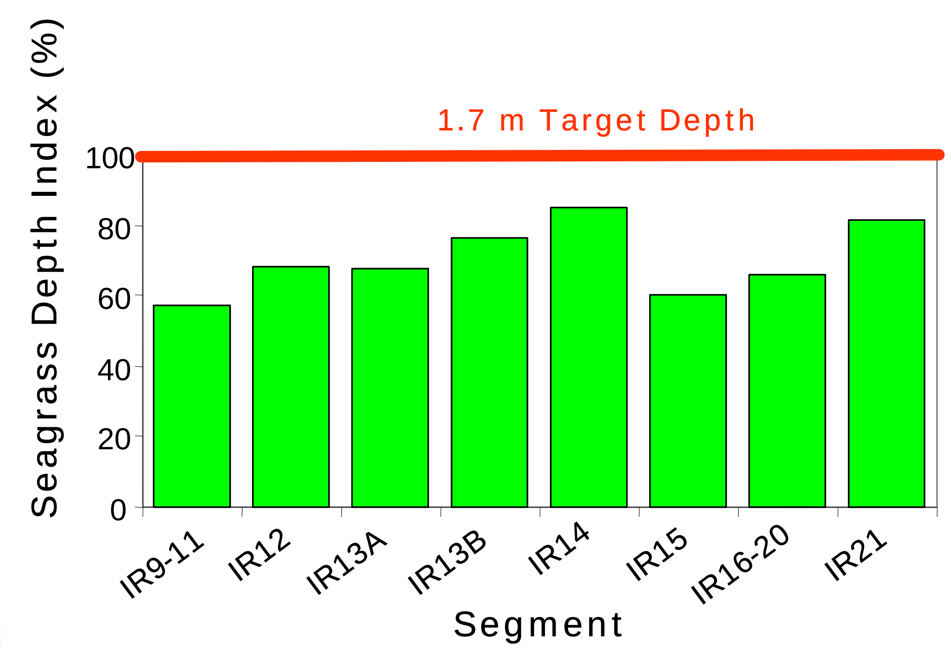

Figure 5-2 d. Average Seagrass Depth Index = depth of edge of bed as a percent of the 1.7-m target depth*. Based on average seagrass deep edges mapped in 1992, 1994, and 1996.

*** The Seagrass Depth Index (SDI) is based on potential coverage to 1.7 m referenced to the NAVD88 vertical datum. The SDI would be slightly less if potential coverage were referenced to mean water level (MWL).**

- Many segments throughout the North and Central IRL showed steady increases in seagrass coverage in the late 1990s (Figures 5-1b and 5-2b), particularly in the poor and fair segments! Is that trend a result of a recent water quality improvement? If so, is the improvement a consequence of relatively dry weather during the seagrass growing season observed in 1998 and 1999[5]; or a result of recent projects that reduced or mitigated pollutant loadings? Or a combination of both? The water quality assessment below should answer the first question, but there are no clear answers to the other speculative questions of causation.

Water Quality Assessment

Within the North and Central IRL, the lowest 10-year average salinity -- slightly above 20 ppt -- was measured in the Cocoa-Melbourne area (segments IR8 – IR13A). These waters are contiguous with the southernmost reach of Banana River Lagoon (south of S.R. 404, Pineda Causeway), which measured a similar low 10-year average salinity of 20.5 ppt. These low 10-year averages apparently occurred because salinities dropped and periodically stayed well below 20 ppt from late 1994 through 1998 (Figure 5-3).

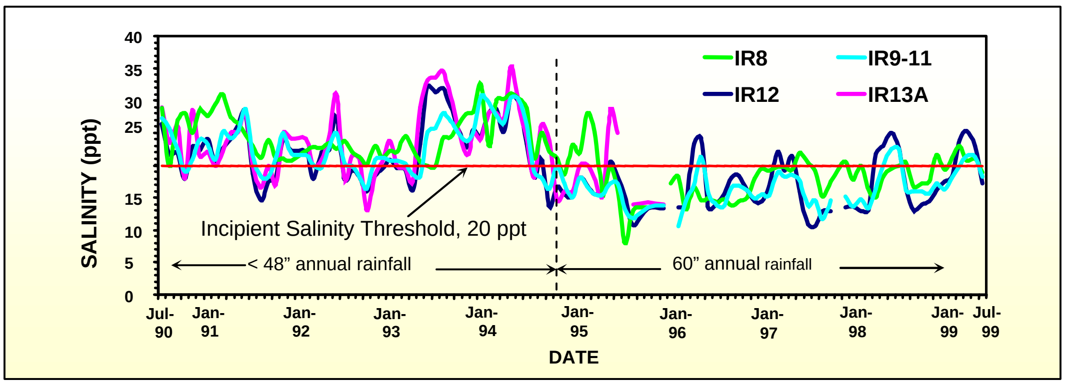

Figure 5-3. Monthly salinity levels from 1990 - 1999 in the Cocoa-Melbourne area (segments IR8, IR9-11, IR12, and IR13A)

Above-average rainfall from 1994/95 through 1998 is one likely factor contributing to the salinity decline in the Cocoa-Melbourne reach. The severity of this impact is compounded by improved drainage systems surrounding several tidal creeks in the area (Horse, Eau Gallie, Crane, and Turkey Creeks). Distance from the oceanic influence of Sebastian Inlet is another important factor in the slow recovery of salinities (25 to 40 miles to Sebastian Inlet from Melbourne and Cocoa, respectively). Salinity spiked above 20 ppt during the drier spring and early summer months. The 20 ppt level has been demonstrated as the minimum salinity to sustain long-term growth of all the IRL seagrass species except for *Ruppia maritima*, which can tolerate lower salinities. Even if water clarity and other environmental conditions are excellent, most seagrasses fare poorly in salinities below 20 ppt. Thus, persistently low salinities in the Cocoa-Melbourne reach probably contributed to the comparatively low seagrass abundance and diversity in the mid to late 1990s (Figure 5-4).

[5] In 1998 and 1999, very dry conditions existed during the first 5 months of the 7-month seagrass growth season (March – September). Less than 16 inches of cumulative rainfall was recorded during the 5-month period (March – July) in each year, which is about 10 inches below the average for the same 5 months during the previous 8 years (National Weather Service data, Melbourne Airport).

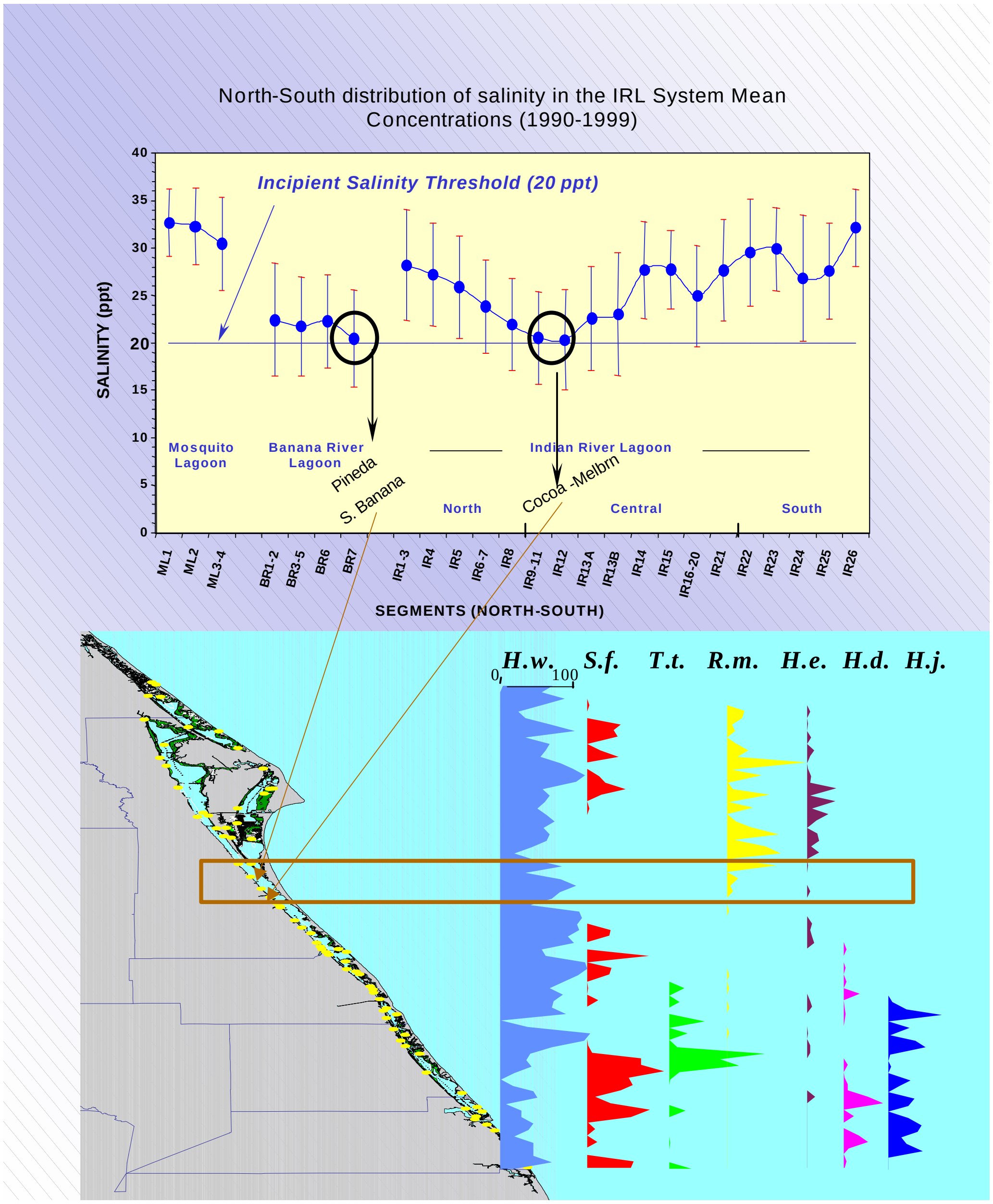

Figure 5-4. 10-year mean salinities +/- S.D. in the IRL system by segment (top plot) and the relative abundance and diversity of seagrasses with an emphasis on the south Banana River Lagoon and Cocoa-Melbourne reach (bottom graphic) where both low salinities and low seagrass abundance and diversity exist

Seagrass Species:
H.w. – *Halodule wrightii* **S.f.** – *Syringodium filiforme* **T.t.** – *Thalassia testudinum*
R.m. -- *Ruppia maritima* **H.e.** – *Halophila engelmannii* **H.d**. – *Halophila decipiens*
H.j. – *Halophila johnsonnii*

Interestingly, *Ruppia maritima* briefly emerged as the second or third most abundant seagrass species in the Cocoa-Melbourne area during the low salinity period of 1996 – 1998 (SJRWMD seagrass transect data).

Elsewhere in the North and Central IRL, salinity levels are typically well above 20 ppt, even reaching annual means of 25 to >30 ppt in the northernmost segments (IR1-3) and in the Sebastian-Vero Beach area (segments IR14 – 21) (Figures 5-5 and 5-6b). Consequently, salinity throughout most the IRL is generally maintained above the 20 ppt threshold and is not considered a problem except in the Cocoa-Melbourne reach (and in south Banana River Lagoon). It is quite probable that low salinity is not acting alone in its presumed impact on Cocoa-Melbourne seagrasses (refer to Figures 5-1 and 5-2 for seagrass status information).

Other water quality factors, specifically any or all of the “optical” pollutants, are likely antagonists as well. The most likely of these are turbidity and color. Two independently conducted studies, one by SJRWMD (analysis of the 10-year record of ambient data) and the other by Harbor Branch Oceanographic Institution (Hanisak, 2001), both concluded that turbidity and color are the primary pollutants inhibiting light penetration in the North and Central IRL. In combination, turbidity and color may account for up to 50% of the attenuation of light through the water column (Hanisak, 2001).

One might expect color to be elevated in certain areas of the Central IRL where there are numerous creeks and canals discharging colored surface water. Indeed, the Central IRL is noted for some of the highest color of any sub-lagoon area. The10-year means range from about 20 to 30 pcu, whereas for most of the other sub-lagoons, the 10-year means range from 15 to 20 pcu.

The Melbourne and Vero Beach vicinities measured the highest color levels in the IRL system. The Melbourne segment (IR12) usually exceeded 20 pcu from 1994 through 1998 (Figure 5-6a). Even higher color levels were measured in the Vero Beach vicinity (segments IR16-20) -- often exceeding 30 pcu as an annual mean from 1990 through 1998. Then, in 1999, while salinities were noticeably increasing, color decreased below 20 pcu in Melbourne, Vero Beach, and throughout the North and Central IRL (Figures 5-5 and 5-6a and b).

One should also expect wet season[6] color levels to be higher than in the dry season. This seasonal pattern is most notable in the Vero Beach segments where the wet season color levels can be 2 to 3 times the dry season levels (from <15 pcu to >30 pcu) (Woodward-Clyde, 1994b).

Turbidity levels need to be quite low in marine or estuarine systems if they are to support healthy beds of seagrass. For the Lagoon proper, turbidity targets in the range of 2.8 to 4 ntu are being considered by SFWMD and SJRWMD. Such levels are routinely exceeded throughout the North and Central IRL (Figures 5-5 and 5-6a and b) (as well as in Mosquito Lagoon and Banana River). The highest levels are found in the Vero Beach area where turbidities are above 6 and 7 ntu as annual means (Figure 5-6b). Unfortunately, turbidity appears to be a problem throughout the IRL system.

Presumably, total suspended solids (TSS) and phytoplankton (measured indirectly as chlorophyll a) are the main constituents that collectively control turbidity levels. Turbidity levels in the North IRL (segments IR1-8) are controlled nearly equally by TSS and chlorophyll a[7]. This trend appears to continue, though weakens somewhat, into the Central IRL from Melbourne to Sebastian. From Sebastian southward through the Vero Beach segments (IR15-20), TSS predominates as the turbidity controlling factor.

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[6] June-October, which overlaps with the seagrass growth season, March - September

[7] Based on the degree of correlation between turbidity and other constituent data (step-wise regression analysis of SJRWMD data)

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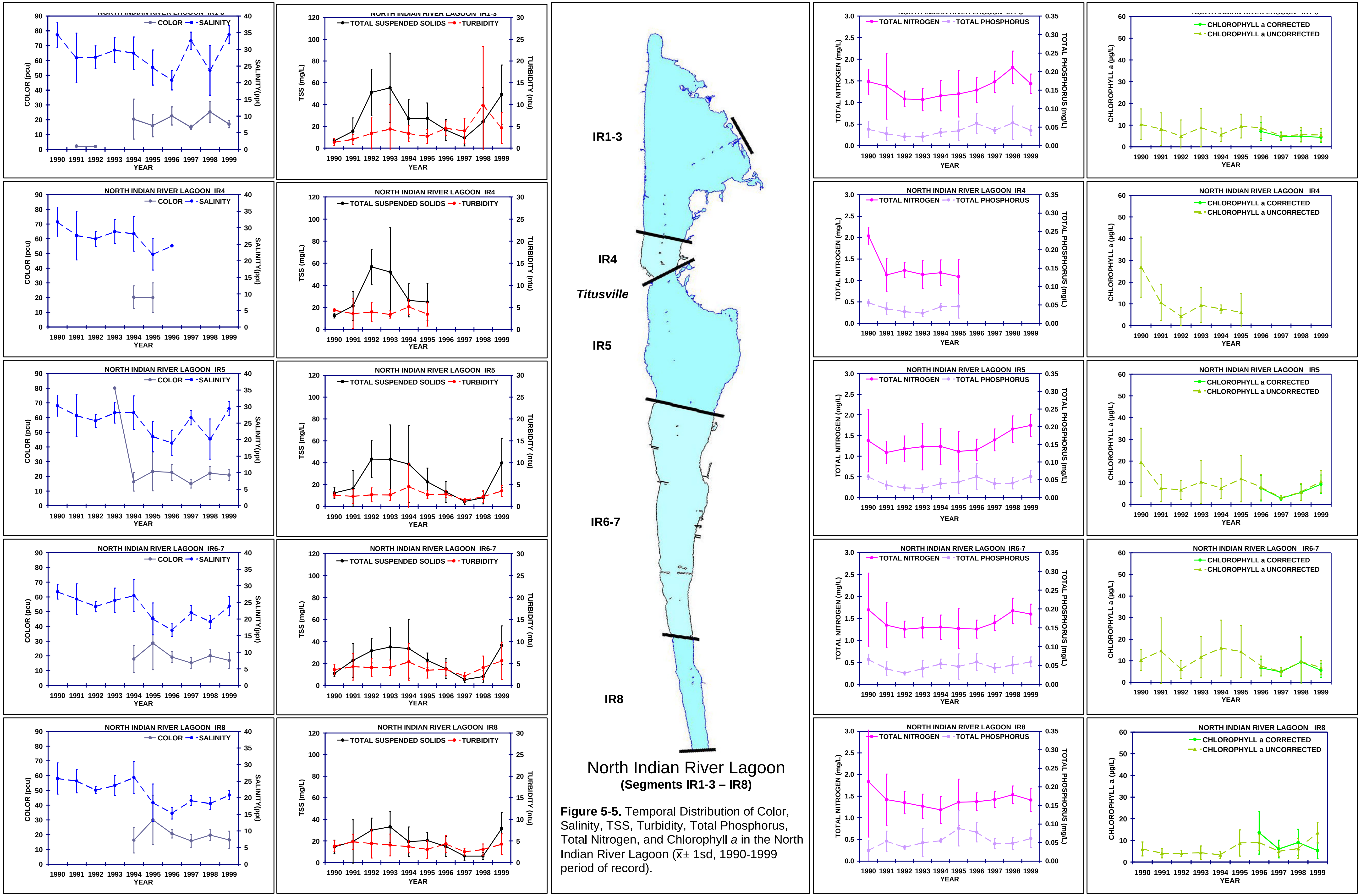
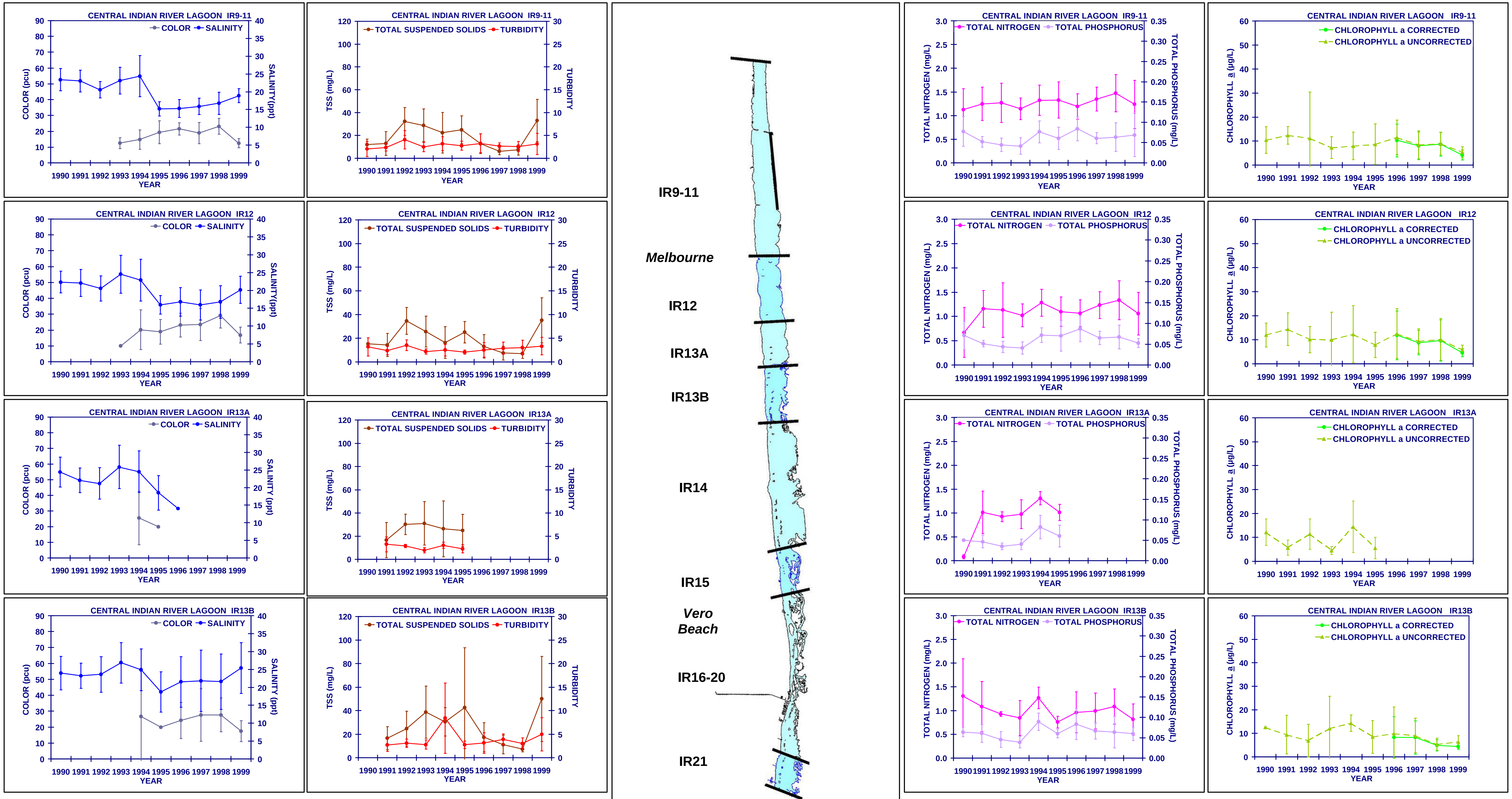
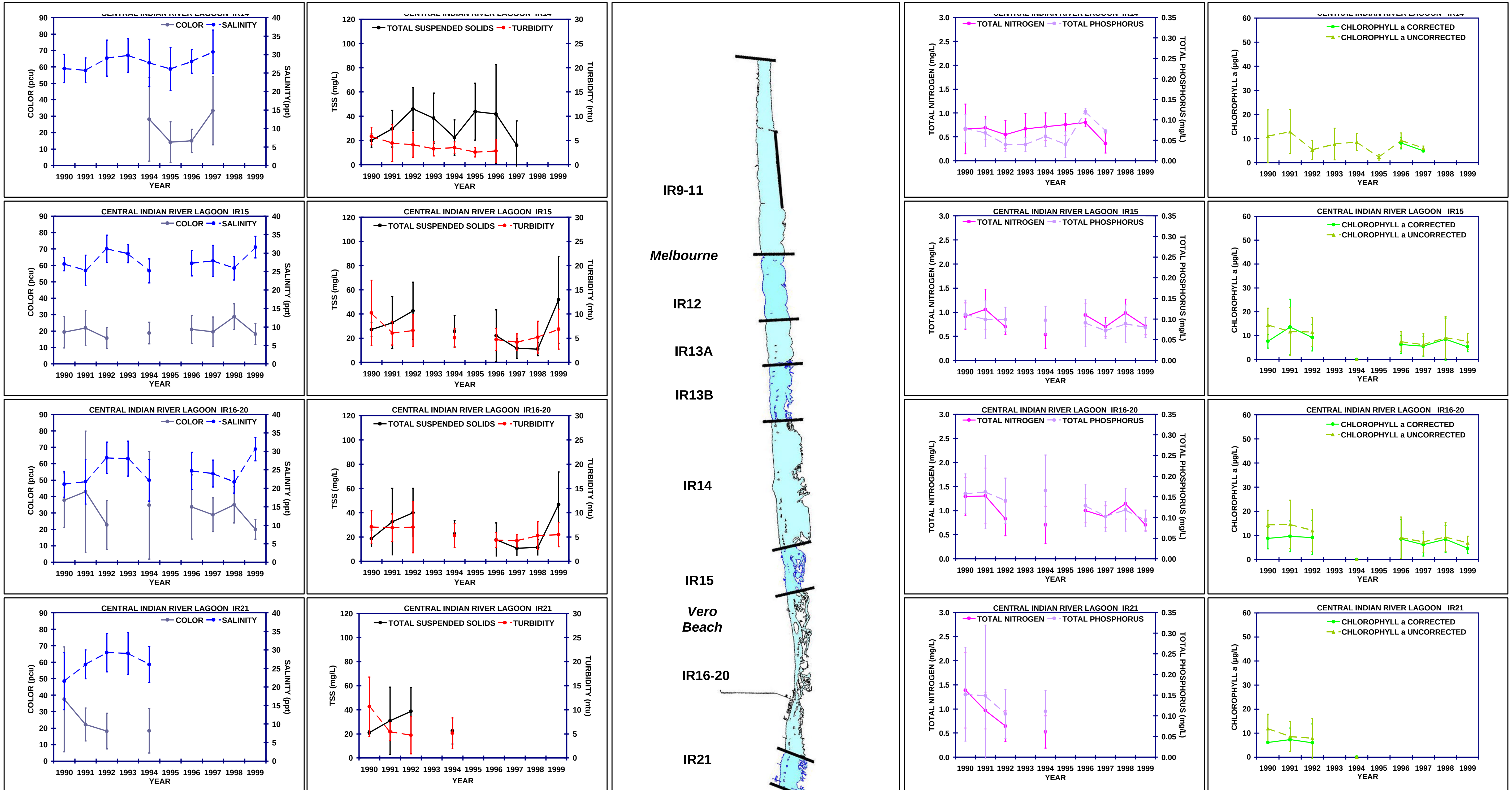


Figure 5-5. Temporal Distribution of Color, Salinity, TSS, Turbidity, Total Phosphorus, Total Nitrogen, and Chlorophyll *a* in the North Indian River Lagoon ($\bar{x}\pm$ 1sd, 1990-1999 period of record).



Central Indian River Lagoon
(Segments IR9-11 – IR21)

Figure 5-6a. Segments IR9-11 through IR13B. Temporal Distribution of Color, Salinity, TSS, Turbidity, Total Phosphorus, Total Nitrogen, and Chlorophyll *a* in the Central Indian River Lagoon ($\bar{x} \pm$ 1sd, 1990-1999 period of record).



Central Indian River Lagoon
(Segments IR9-11 – IR21)

Figure 5-6b. **Segments IR14 - IR21**
Temporal Distribution of Color, Salinity, TSS, Turbidity, Total Phosphorus, Total Nitrogen, and Chlorophyll *a* corrected in the Central Indian River Lagoon ($\bar{x}\pm$ 1sd, 1990-1999 period of record).

TSS in the IRL contains a mineral to organic content ratio of about 2.5 to 1 (SJRWMD data), which is similar to that of muck sediment. Muck is largely mineral soils (clays and silts) eroded from land and mixed with organic detritus (Trefry et al., 1990). The Vero Beach segments contain some of the more extensive deposits of muck in the IRL system (excluding Sebastian and St. Lucie Rivers). Nonetheless, like Vero Beach, other highly developed areas in the North and Central IRL also contain large or numerous deposits of muck – Titusville, Cocoa-Rockledge, and the Melbourne-Palm Bay reach (Trefry et al., 1990). Resuspension of deposited muck and inputs of new material via land runoff and stream discharges are probably the processes that result in suspended material in the Lagoon. Given that these processes are more pronounced in the Central IRL than in the North IRL[8], it is conceivable that suspended solids would be a significant influence on turbidities in Central IRL and especially in the Vero Beach segments.

TSS fluctuates widely within and between years throughout the North and Central IRL, even in the good seagrass segments (IR1-5, IR13B, and IR14), with mean annual concentrations ranging between <10 mg/l and more than 50 mg/l (Figures 5-5 and 5-6). Some of the lowest concentrations were observed from 1996 through 1998 (and into early 1999 in many areas), dropping well below 10 mg/l, only to dramatically rise in mid-1999 to 40+ mg/l (Figures 5-5 and 5-6).

In contrast, mean annual chlorophyll *a* concentrations throughout the North and Central IRL were fairly stable over the last decade; tightly fluctuating around a mean of 10 µg/l. For most segments, mean annual concentrations even declined to less than 6 µg/l from 1997 through 1999 (Figures 5-5 and 5-6). While 'bloom' concentrations of 30-50 µg/l do occur sporadically, this evaluation of the ambient data and other studies (SFWMD, 2000; Kenworthy and Fonseca, 1996) suggest that phytoplankton production has not reached and maintained levels that would substantially impinge on light penetration. Nonetheless, chlorophyll *a* or phytoplankton is a contributory factor, particularly in the Central IRL (Hanisak, 2001), and nutrient management is important as a means to *prevent* this factor from taking a larger role. The need for nutrient management is further emphasized by studies that show epiphytic growth (attached algae) on seagrass blades may shade as much as 50% of available light to seagrass blades (Harden, 1994; Dixon, 2000).

Based on spatial and temporal trends in nutrient concentrations (Figures 5-5, 5-6, and 5-7) and a study to identify the limiting nutrient(s) in the IRL system (Phlips et al., 2001), it is clear that nutrient management in the IRL basin must consider both nitrogen and phosphorus. It was concluded by Phlips et al. (2001) that the IRL is nutrient-rich and that phytoplankton production is held below its potential because of two factors: flushing and grazing. Another conclusion of the study was "while nitrogen appears to be the most widely limiting nutrient in the IRL, phosphorus also plays a relatively important role… [especially] where the influence of freshwater inflow on water chemistry is most pronounced." Increasing concentrations of total nitrogen in North IRL (Figures 5-5 and 5-7) and the very high concentrations of total phosphorus in the Vero Beach vicinity (Figure 5-7), also indicate the need to target both nutrients in pollutant reduction strategies.

[8] Over 65% of the muck volume in the entire IRL system resides in the Central IRL. The Central IRL basin non-point loading of suspended solids is about 4 times that in the North IRL: **>**32 million lb/yr in Central IRL vs. ~8 million lb/yr in North IRL. There is more discussion of suspended solids and nutrient loadings later in this chapter.

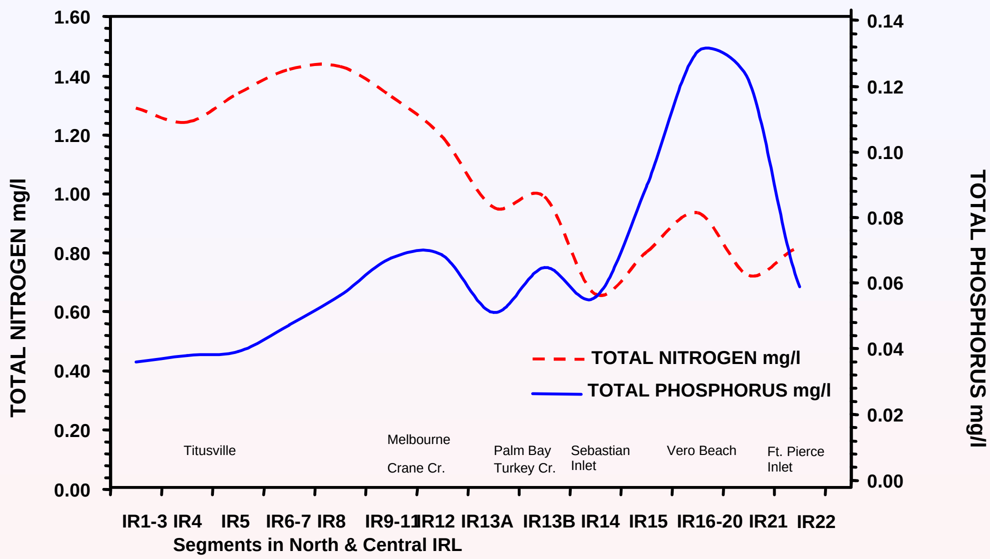


Figure 5-7. North to south spatial trends in total nitrogen and phosphorus concentrations in the IRL

Summary of Assessments

The seagrass resource in the northernmost IRL segments (segments IR1-5) and in the Sebastian segments (IR13B and IR14) in the Central IRL are considered to be in good condition. The probable factors that allow good seagrass conditions are different in the North than in the Central IRL. The northernmost segments are poorly flushed but their watersheds are not extensively developed and do not generate the large pollutant inputs characteristic of the Central and South IRL. Alternatively, the segments adjacent Sebastian Inlet are located in large and developed watersheds, but are well-flushed due to the inlet tide (up to a week for a nearly complete volume exchange; Sheng, 1997).

The worst segments are the Cocoa-Melbourne segments (IR6-7 and IR9-12) and Vero Beach segments (IR16-20). Both are relatively narrow, low volume reaches receiving large drainage and pollutant load inputs from highly developed watersheds. While the Cocoa-Melbourne area did show modest gains in seagrass coverage in the late 1990s, the coverage in the Vero Beach segment remained quite low.

Turbidity and suspended solids fluctuate greatly and both are a problem throughout the IRL in good, fair, and poor seagrass segments alike. So, what appears to set apart the good and poor seagrass segments is color and salinity. Color is comparatively higher in Cocoa-Melbourne (usually >20 pcu annual average) and especially in the Vero Beach segments (usually >30 pcu annual average) than in other North and Central IRL segments. Additionally, the Cocoa-Melbourne area is susceptible to prolonged periods of low salinity (<20 ppt) and problems of light attenuation related to color and turbidity.

The significant gains in seagrass coverage observed in 1999 in most of the fair and poor segments occurred when salinities rebounded to >20 ppt, color levels were <10 pcu (annual mean), and chlorophyll *a* concentrations were <6 µg/l (annual mean). However, turbidities and suspended solid levels showed no declining trend. Indeed, turbidities and suspended solids seem to be persistent problems throughout the IRL system.